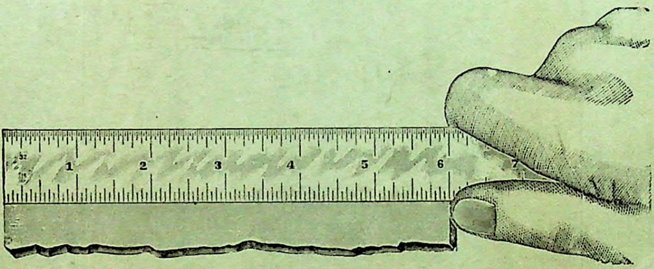
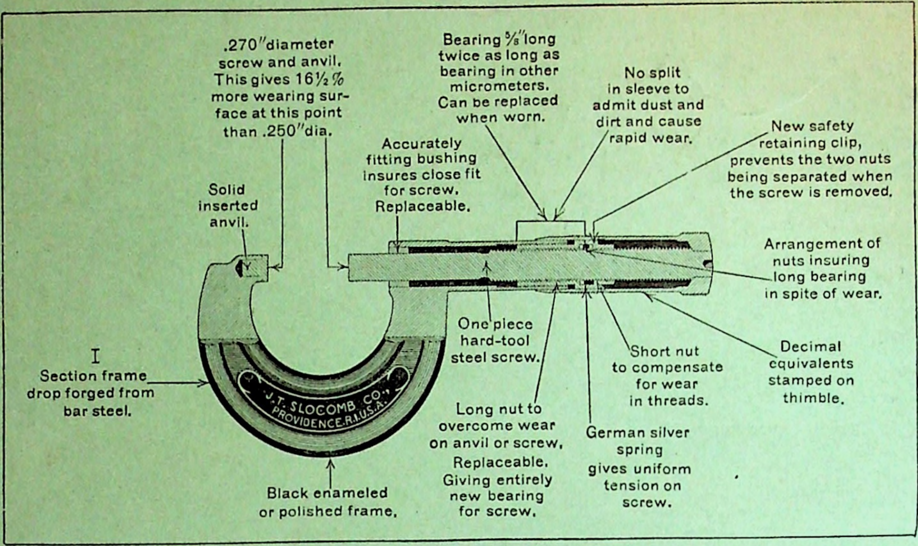
THE MEASURING BOOK

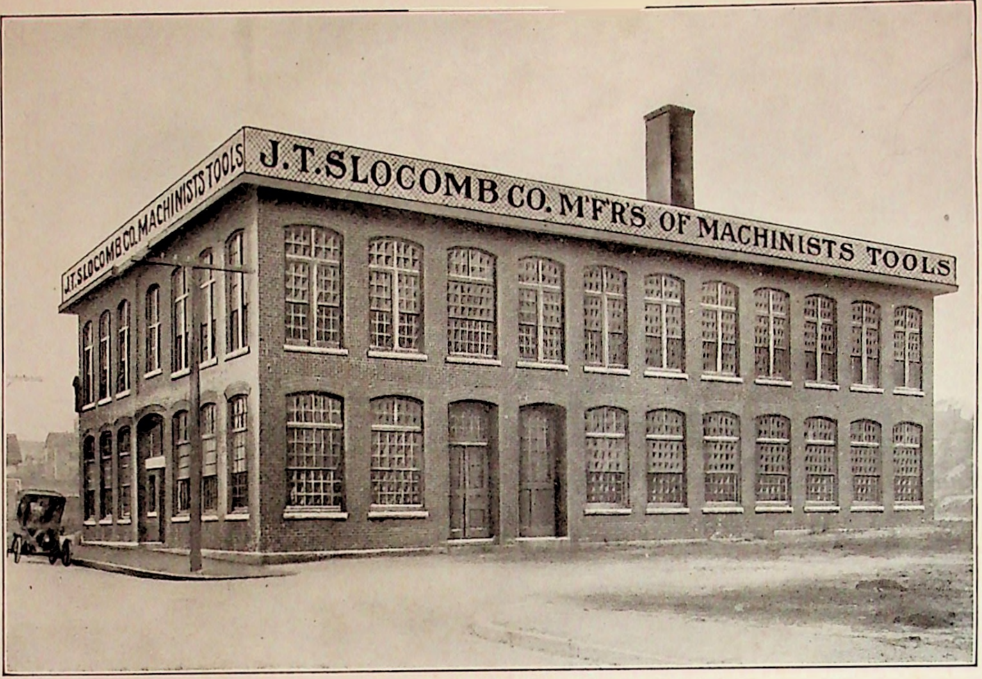


WITH SUGGESTIONS IN REGARD TO ACCURATE
AND ECONOMICAL MEASURING
IN MACHINE CONSTRUCTION
BY THE USE OF MICROMETER CALIPERS

PUBLISHED BY
J. T. SLOCOMB COMPANY
PROVIDENCE, R. I.
U. S. A.



.270″diameter screw and anvil. This gives 16½% more wearing surface at this point than .250″dia.
Bearing ⅝″long twice as long as bearing in other micrometers. Can be replaced when worn.
No split in sleeve to admit dust and dirt and cause rapid wear.
New safety retaining clip, prevents the two nuts being separated when the screw is removed.
Solid inserted anvil.
Accurately fitting bushing insures close fit for screw. Replaceable.
Arrangement of nuts insuring long bearing in spite of wear.
I Section frame drop forged from bar steel.
J.T. SLOCOMB CO. PROVIDENCE.R.I.U.S.A.
One piece hard-tool steel screw.
Short nut to compensate for wear in threads.
Decimal equivalents stamped on thimble.
Long nut to overcome wear on anvil or screw. Replaceable. Giving entirely new bearing for screw.
German silver spring gives uniform tension on screw.
Black enameled or polished frame.


J. T. SLOCOMB CO. M'F'R'S OF MACHINISTS TOOLS
J. T. SLOCOMB CO. MACHINISTS TOOLS

J. T. SLOCOMB COMPANY - Micrometers - Providence, R. I., U. S. A.

An up-to-date factory—fireproof—stands alone, affording best light and air. Supplied with spring water from artesian wells. We have improved lathes which cut the most accurate Micrometer screws in the world.

OUR BUILDING

is of particularly heavy construction designed specially for our work.

The character of our tools and the great accuracy required in their manufacture suggested the most substantial type of construction to eliminate as far as possible all vibration.

It is complete in all details and equipped with every modern appliance. Our machinery is largely special in character and of our own design, built with the idea of producing the greatest possible accuracy in our Measuring Tools and Comparators, etc.

Our lathes for cutting Micrometer Screws represent the highest mechanical attainments and are the best that can be produced.

OUR CLAIMS

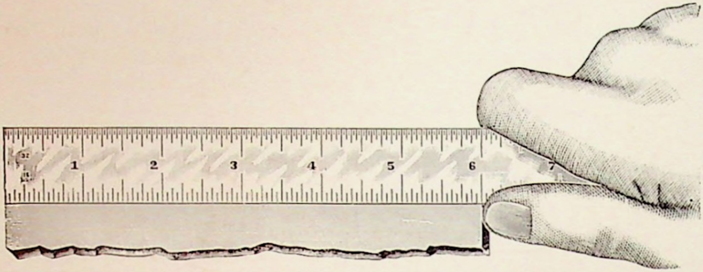
Without hesitancy we claim to manufacture the most accurate and long lived Micrometer Calipers.

We guarantee our product in every particular, and are thoroughly familiar with every detail of our manufacture, with an experience of twenty-three years. Our ability is devoted to just two lines, Micrometer Calipers and Combined Drills and Countersinks.

We also claim the largest and most complete plant for the manufacture of these two lines, and are therefore prepared to furnish what you require—accuracy.

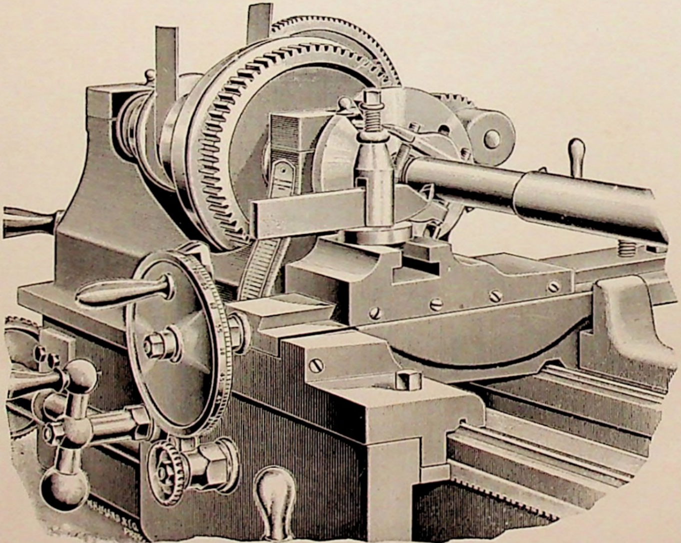
Our Micrometer Calipers are regarded as the standard everywhere by the best mechanics. Our type is our own.

Combined Drills and Countersinks were developed and put first on the market by ourselves and are to be found in every shop.



USING A COMMON RULE

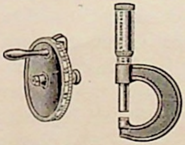
In measuring with an ordinary rule as shown above we not only know that the piece measured is the size wanted, but can know how much larger or smaller. When the machinists' trade was in its infancy, such measuring was in common use, but it did not prove fine enough for a large part of the work; consequently, the solid gauge or ordinary caliper was adopted. This solid gauge provided a means



Graduated Dial Lathe Cross Screw

of gauging more accurately than the common rule, but it lost entirely the feature of *measuring;* that is, the workman has no way with the solid gauge of knowing how near he is to the size, until the exact size is reached. This difficulty led to the adoption of the limit gauge. A limit gauge, as commonly made, has two sizes, one marked "To go on," the other marked "Not to go on," so that somewhere between these two sizes is the size required. This is much better than the single gauge, but it is a very incomprehensive way of measuring; besides where these limit gauges are carried out to fill all requirements, the system is very complicated, as it requires thousands of such gauges, and such a complete set is very expensive. What the machinists require is a rule that can be used practically the same as the common graduated rule that will show when the exact size is reached, and also how near at any stage of the work, and show this in a way that is accurate. Such a tool is found in the Micrometer Caliper. A very common error in using a Micrometer is in setting it to some particular size and locking the spindle fast, then using it like a snap gauge. In such a way it is only a solid gauge, and loses, practically, all its valuable features. The way to properly use a Micrometer is to first become familiar with its reading so the exact size can be read quickly; then in every case measure the work with it, that is, whatever the work is, screw the caliper down to it and take its reading.

GRADUATED DIAL ON LATHE CROSS SCREW


Partners in Profit

To make the best use of Micrometers, all the adjusting screws on machines should be provided with graduated dials reading in thousandths. The illustration on page 4 shows the dial we use on small lathes. The quill is turned up straight for about 1¼ inch, and the pointer is mounted on this by split clamp, so it can be moved to make the zeros coincide when desirable. Usually we do not move this pointer, but make calculation between graduations. It is not necessary that the screw be absolutely accurate to pitch, as the adjustments necessarily made by this dial are small, so a slight error is not harmful; also backlash in screw is not fatal, as this can be taken up before reading is started on dial. To turn to an accurate size, first round up the work, then measure with Micrometer, after which make necessary adjustments by dial, being sure to be on safe side. Turn down first to about 5 or 10 thousandths of size. The last 5 thousandths can be adjusted accurately by dial even, if screw is not very accurate. This avoids the common "cut and try method" with its consequent loss of time and spoiled work. The thing of course required is, that the user becomes accustomed to the dial, so that he makes his calculations quickly and accurately. Besides using to adjust for sizes, this dial is useful for other purposes, as in adjusting lathe for turning tapers, alignment of centers, gauging cuts in cutting screw threads, and many other cases too numerous to mention. For the longitudinal movement we use a Micrometer head fitted in a bracket that is clamped on the ways of lathe. This is a most useful tool for adjusting side cuts accurately.

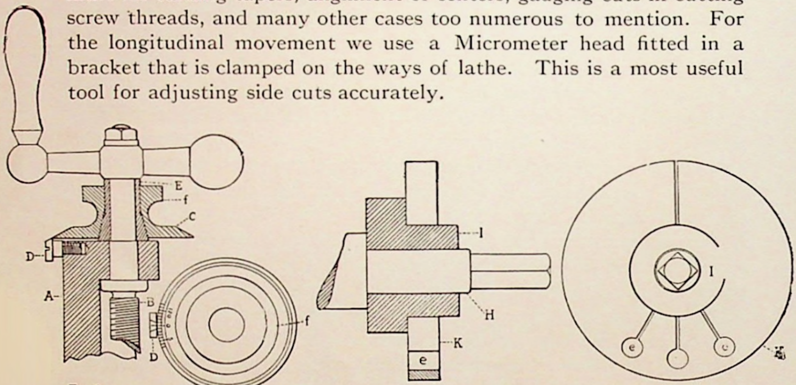


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Dials used on Shaper

The above cuts illustrate dials used on shaping machines. Fig. 3 and Fig. 4 are of dial used on table feed screw. This is simply a Cast Iron Disc, with plain bore and split as indicated, so that it makes a spring fit on hub. In this case we use a stationary pointer, and turn dial to make zeros coincide. This is a cheap and handy dial. On the vertical feed screw, the dial is fitted on a taper quill, the pointer being stationary, and dial is moved by raising it slightly off its seat, and dropping it back again when the zeros coincide. The pointer used is simply a tap screw, with one side of head flatted off to correspond with angle edge of dial, with straight line cut across to match with lines on dial.

These dials we have used for many years. Our men have become used to them, and they have proved great time savers. We find the following article in the *American Machinist* of January 28, 1915, and have its permission to use it here:—

"If dials on the cross-feeds were graduated to read the diameters of the piece in the lathe instead of being graduated to indicate the amount the tool is advanced, we would get rid of some of the figuring and would know the diameter by inspection of the dial instead of repeated use of the Micrometer. This advantage can be obtained by placing twice as many graduations on the circumference of the dial as there are thousandths of an inch in the lead of the screw and advancing the figures on the dial in a clockwise direction instead of counterclockwise as is now universally done.

"THE DIAL ON A 20-THREAD FEED-SCREW

"A front view of a diameter-measuring dial for a cross-feed left-hand screw having a lead of 0.050 inch is shown in Fig. 1. One turn of the screw advances the tool 0.050 inch, representing a change of diameter of 0.100 inch. Thus the dial is divided into 100 parts, each representing 0.001 inch on the diameter.

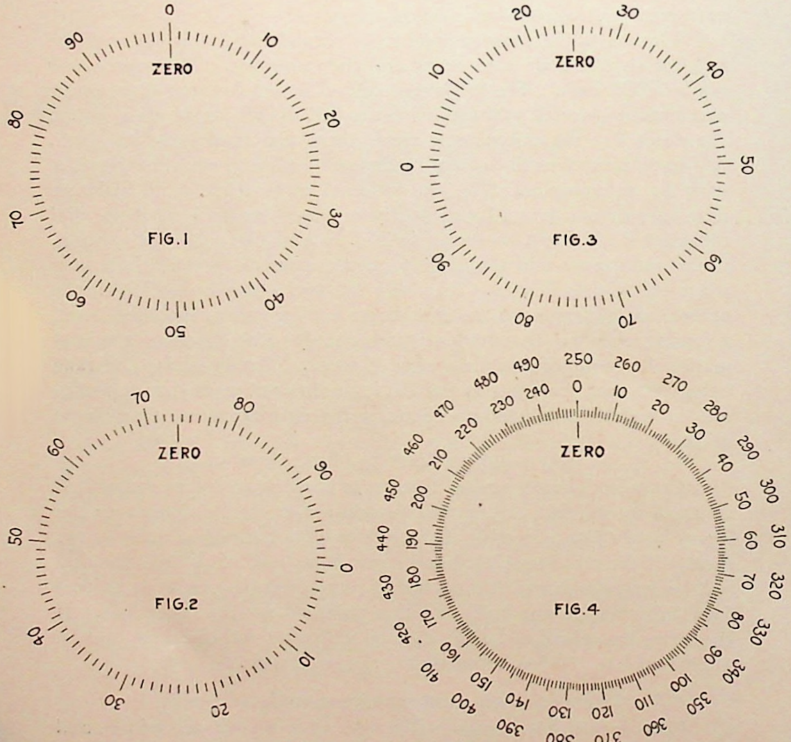
"Place a ¾-inch bar of steel to be turned to 0.625 inch in a lathe fitted with this dial; take a cut and then measure. The micrometer reads 0.6735 inch. The 0.6 is represented by whole turns of the screw and may be ignored, so the dial is set to 0.0735 inch, as shown in Fig. 2, the exact size the micrometer reads above the tenths and the inch. Advance the tool until the dial reads 0.050 inch and measure the piece with the micrometer. The size is found to be 0.650 inch. We are now sure of our ground and boldly advance the tool until the dial indicates 0.025 inch, as shown in Fig. 3, and cut with that setting. On measuring we find the diameter of the piece to be 0.625 inch, just what the dial indicated. Provided the tool point is level with the center, we can proceed to turn pieces having steps, shoulders, etc., referring only to the drawing and occasionally checking the dial setting for wear of tool or spring of work. The lathe for the time being acts as a micrometer, and we do not have to cover it with memoranda in chalk and keep on checking the figuring to see there is no mistake.

"APPLIED TO VARIOUS LEAD-SCREWS

"Cross-feed screws having 20 turns to the inch are, of course, limited to small lathes, but the diameter-reading dial can be applied to the larger lathes just as readily if the screws have ten or five turns to the inch. If the cross-feed left-hand screw has a lead of $\frac{1}{10}$ inch, the dial will be graduated into 200 parts and numbered (clockwise as before) from 0 to 100 on one half, and this repeated for the other half. If the screw has a lead of $\frac{1}{5}$ inch, the dial will have 400 divisions and be numbered 0 to 100 four times on the circumference.

"THE DIAL ON AN EIGHT-THREAD LEAD-SCREW

"Most lathes have cross-feed screws with a lead of ⅛ inch, and while the numbering and reading of dials on them is not so convenient as the above, it can be done as shown in Fig. 4. This dial has 250 divisions and is numbered clockwise from 0 to 250 in one turn. The figures are then carried on from 250 to 500 on another circle more remote from the graduations. In working with such a dial the inches and half inches have to be ignored. For example, I have in the lathe a piece 4 inches in diameter to be turned down to 3.875 inches diameter, tool finish. I take a cut, and on measuring find the size to be 3.913 inches. I ignore the 3½ inches and set the dial to 413 inches. Turning the cross-feed screw till the dial indicates 375 inches, I take a cut and find the diameter to be 3.875 inches. In this case I have to subtract 0.500 inch from the size my micrometer reads and have to

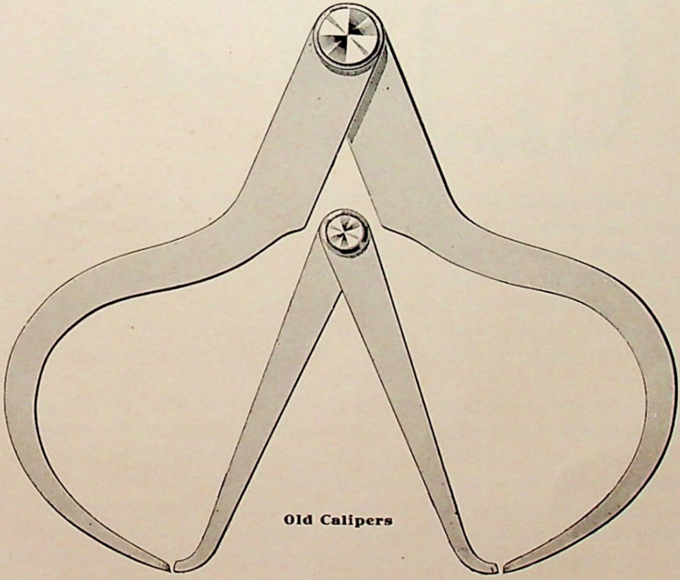


Micrometer Dials on Lathes

keep in mind that the dial does not read the size of my job when the odd half inches have to be taken into account. However, half-inch errors are quickly located; it is the odd thousandths that bother us most.

"In boring holes, too, this system of dial numbering is just as effective. A trial cut is taken, the hole measured and the dial set to that size. It will be seen that as the tool is fed out and the hole enlarged, the dial continues to read the size of the hole, thereby eliminating the necessity of readjustment."

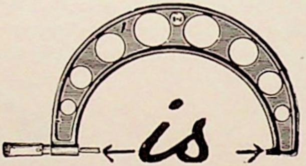
Using dials in this way it will be noted that with fine 20 pitch screws, graduations are fewer and coarser and the reading is simplified. Adjusting screws on large machines are made coarse to enable quick traverse in the various manipulations. In connection with this method of tool adjustment we suggest as an improvement in machine tools an extra short screw adjustment in the thrust bearing, giving an advance of .050 per revolution so that quick long adjustments can be made in the regular way and fine short dial adjustments by the auxiliary screw. This auxiliary screw would then get little wear and would remain accurate for a long time.



Old Calipers

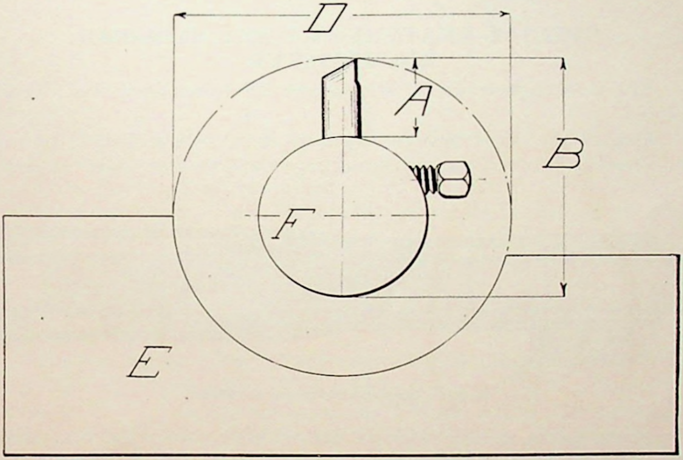
OLD-FASHIONED INSIDE AND OUTSIDE CALIPER

The cut on page 9 illustrates the fitting together of an old-fashioned inside and outside caliper. Note that the points are small, and on account of the different angles of legs, it is impossible to shape these points so that they can have any considerable bearing. To match these calipers together so they will exactly fit is a delicate operation and requires some skill, a good deal of time and lots of patience. In view of the fact that the Micrometer Caliper can be used so much easier in this operation, this process nowadays seems to be the height of absurdity. Using an outside Micrometer with its large parallel measuring surfaces, it is a very easy matter to adjust an ordinary inside caliper to the exact size. All that is required is to hold one point against the anvil of Micrometer, and swing the other leg back and forth, finding the shortest distance. It is often the case that when the points touch, the user would like to know just how hard they touch; that is, how much spring there is to the caliper. This is easily ascertained by turning the Micrometer screw back one thousandth or more, and note if the points will touch at all in this position, proving the amount of error in the adjustment of inside caliper.



The difference between "about" and "is" is often the difference between success and failure. The "about" caliper has its use to-day, but that use is not in finishing work accurately. The shop that persists in such ancient methods to-day is on the road to failure, unless it so happens that it has a very bonanza-like monopoly, a thing some of us dream of but have not seen. We have heard of the shop where everything is wasted; labor, stock, and tools destroyed, where incompetence reigns, and where the firm is still making money, but where is it?

The thousandth part of an inch has been found the most convenient unit for the accurate part of machine work. This unit lends itself readily to most calculations and is much more convenient to use than ordinary fractions. There are many times when Micrometer accuracy is not necessary, but when it is found advisable to use the Micrometer with decimal measurements for convenience. For instance, the diameters of gears are more conveniently measured and figured in decimals.



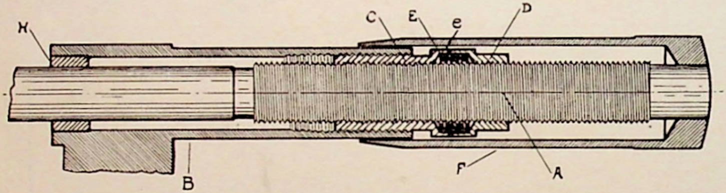
Another illustration of the convenient use of Micrometers and decimals is illustrated in the accompanying line cut. This illustrates the boring with a boring bar of a segment of a circle. This segment "E" is less than half a circle, so it cannot be measured in the regular way. The boring bar "F" is made to run true on the lathe centers, and its diameter is measured with a Micrometer. By subtracting one half the diameter of the boring bar from one half the required diameter of the segment "E," the overhang "A" of the boring tool is found. Now by adding this length "A" of the boring tool to the diameter of the boring bar gives the dimension "B," which is easily measured across from back of the boring bar to the cutting edge of the tool with the Micrometer, and so the adjustment is made to accurately cut the circle in segment. There are many similar ways that calculations can be made so that measurements are accurately and easily made.

While the thousandth part of an inch is the most convenient unit, and is fine enough for the general run of machine work, still there are times when this must be further divided. On an ordinary Micrometer one half and one quarter thousandths are easily estimated. Where finer measurements than these are required, we have Micrometers graduated with a vernier arranged so they will read direct on the thimble in ten-thousandths. Finer measurements even than these are made with measuring machines, but of course every degree of refinement adds greatly to the cost.

SPECIAL FEATURES OF THE SLOCOMB MICROMETER

The construction of this Micrometer differs considerably from all others.

One of the most important improvements embodied, is in the adjustment between the measuring screw and its nut. This is done by drawing the spindle back in line with its axis, which keeps all threads in contact and does not shorten the length of wearing surface, as when the adjustment is made by pinching together one end of nut, as is usual. A long bearing on screw insures uniform wear. Large wearing surface, together with the hard stock the screws are made of, gives the Slocomb Micrometer a long life even under severe work.



Section through Micrometer Head

The total area of surfaces in contact between one side of threads of screw and its nut is about ⅜ of a square inch, or about six times the area of face of anvil. It should be understood, in a tool where accuracy is so very essential, that its life and value depend upon the extent and nature of its wearing surfaces. A short bearing of the nut on measuring screw will wear the screw out of pitch. Besides these liberal wearing surfaces, the screw is made of *tool steel*, of as high temper as can be cut. *The Slocomb Micrometer is the only one with an all tool steel screw.* These hard screws resist wear and abrasion. The Slocomb Micrometer will remain accurate after long use.

Another valuable feature not found in other micrometers lies in the spring. This spring produces a slight uniform friction on the spindle, so it is never loose at any point and will not move around of its own accord. Incidentally this spring keeps the spindle back in its seat, and does not call for a rigid fit between spindle and nut with its consequent danger of roughing up and seizing.

The anvil is a tool steel plug, hardened and forced in frame and is practically solid with the frame. The bearing supporting the plain part of spindle is a bushing and is easily renewed when worn.

The spindle is adjusted down to compensate for wear on anvil by turning the main nut. This is a differential screw adjustment and is very fine.

We have improved lathes that cut the most accurate screws in the World.

All frames to the 9 inch inclusive are drop-forged from bar steel; larger sizes are steel castings.

These Tools are not an experiment.

They have been in use since 1894 in the best shops all over the World, and have been thoroughly tested.

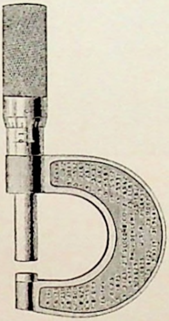
SECTIONAL CUT MICROMETER HEAD

The illustration on page 12 represents a section through the head of the Slocomb Micrometer. The spindle "A" is attached rigidly to thimble "F." This spindle is threaded 40 pitch, and passes through main nut "C," also is supported at "H" by bushing, which bushing is forced into frame "B." The main nut "C" is threaded externally 32 pitch, and is a tight screw fit in frame "B." Now, with parts in place as shown, turning nut "C" will advance spindle "A" the amount of difference in pitches between 32 and 40, or .006¼ per revolution. This is the adjustment for wear on measuring terminals that is ordinarily done by adjusting an anvil screw. This is a decided improvement, as it allows of using a solid and substantial anvil, also provides a very fine adjustment; that is, it takes a considerable movement of nut "C" to make a small change in the adjustment. On the face of the nut "C" and nut "D" there are 56 V-shaped teeth milled, forming a clutch. In the recess between these two nuts there is a light coiled spring "E." When these two nuts are clutched together, and spindle screwed through, it is impossible to separate them. This arrangement allows of two forms of adjustment for taking up wear in threads of screw. First, the rigid adjustment, which is done by advancing the small nut one or more teeth, and second, a flexible adjustment produced by spring "E." After fitting these two nuts together, a line is cut outside, marking point where they are fitted. This construction also allows of making cheap repairs, in case of accident or extreme wear. By putting in new bushing "H" and main nut "C" the original alignment is restored.

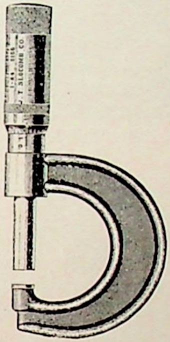
Caution: To make adjustment, a spanner wrench is furnished fitting slot "e" in main nut "C." In turning this nut the wrench should be held down firmly, so as not to slip and tear out slot, as these nuts start rather hard. To know exactly how much to turn the main nut, first measure an accurate standard and find the exact fraction of a thousandth that is needed for adjustment. For illustration: Suppose it is found that spindle needs adjusting down .000¼. As turning adjusting nut "C" one whole revolution advances spindle .006¼, then adjusting down .000¼ would mean turning nut 1/25 revolution, or the amount of one division of thimble. To do this turn thimble back until its end matches inside of slot on main nut "C" and one line corresponds with the left side of slot, when holding tool with thimble pointed away from the eye. Now, draw lead pencil mark on sleeve "B" to correspond with next line on thimble, after which turn thimble back sufficient to allow for using wrench and turn nut to the right, so that edge of slot corresponds with lead pencil mark. This is moving nut the amount of one division of thimble. For .000½ adjustment, turn the amount of two divisions, or for .001 adjustment, turn the amount of four divisions. By this method it is easy to adjust these micrometers to an accuracy of .0001 without making a second attempt. Sometimes, for inspection, a person who is not familiar with the construction will get the small nut detached, and lose it up inside of thimble. There is absolutely no occasion for this, as these nuts cannot be separated, except by running spindle back about ½ inch beyond last graduation, a thing that is never necessary to do except for inspection or repair. When this is done it is a very easy matter to match nuts according to line cut on outside and hold them together closely, until screw is entered in main nut, when they cannot be separated.

TWO STYLES ONE-INCH MICROMETER

Referring to cuts, the one to the left represents a one-inch Micrometer with pressed flat frame, and complete table of decimal equivalents, consisting of 8ths, 16ths, 32ds and 64ths, raised above the surface. The frames in these tools are drop-forged, then polished, after which they are pressed in dies, consisting of two side members and a retaining ring. These dies are practically the same as is used in coining money. That is, the work is entirely confined in the die, so it cannot spread and must fill every part of die when sufficient pressure is applied. For this particular piece a pressure of three hundred tons is used. This work is done in a hydraulic press. These dies are finely polished, so that no further finish is required on side of frames after pressing.



No. 26

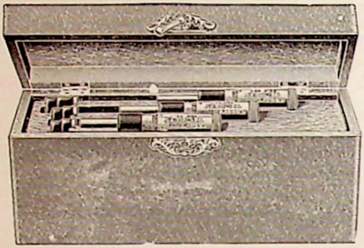


No. 25

The Micrometer at the right has a frame drop-forged to an I-section, giving the greatest rigidity with least weight. Also this frame allows of easy handling, as the recesses make a very good finger hold. When the workmen's hands are oily, this aids in accurate measuring, as the tool can be handled more delicately. These frames are finished in black enamel. The thimble on this tool has a complete table of decimal equivalents, consisting of 8ths, 16ths and 32ds, rolled almost completely around same. In other respects this caliper is the same as the other.

MICROMETER CALIPERS IN SETS

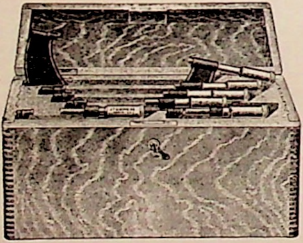
Many years ago the custom was quite general for the workman to buy all his own small tools. These tools were simple and inexpensive, and it was quite practical for him to do so. Later, more expensive tools were required, and the firms began to buy such tools as a part of the shop's equipment. A good outfit of Micrometer Calipers should be as much a part of the outfit of a modern shop,



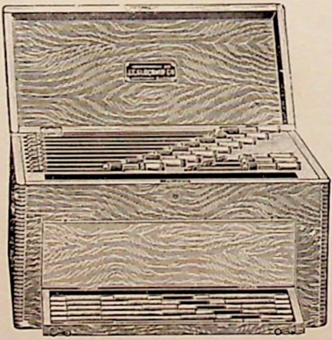
No. 18 Set

No. 21 Set

as machine tools. These set cases provide means of properly taking care of the calipers. Sets with oak cases, provided with lock and key, are good where there is no tool room, and where the foreman is obliged to care for these tools in the shop. For tool rooms the racks are more convenient.



No. 19 Set

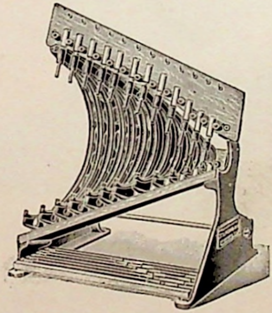


No. 22 Set

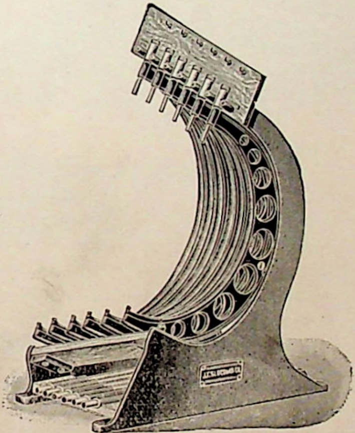
The No. 18 and No. 21 Sets are intended particularly for the individual workman. The cases for these sets are covered with morocco leather. These sets contain three micrometers only, a 1 inch, 2 inch and 3 inch.

The No. 19 and No. 22 Sets have a substantial oak case, with lock and key. The No. 19 Set contains six micrometers from 1 inch to 6 inch inclusive. The No. 22 contains twelve micrometers from 1 inch to 12 inch inclusive, together with a set of End Measures from 1 inch to 12 inch. This set of End Measures fits into a grooved small case, and this small case in turn fits into a slot in main box, as shown.

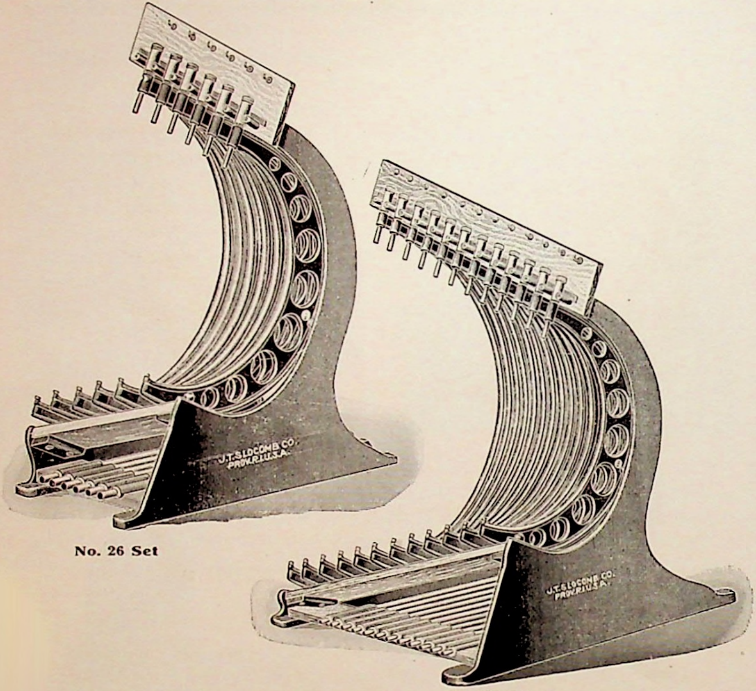
The No. 20, No. 24, No. 26 and No. 28 Sets are intended for the tool room. The No. 20 Set consists of twelve micrometers from 1 inch to 12 inch and set of twelve End Measures to correspond; the No. 24, six micrometers from 13 inch to 18 inch inclusive, with End Measures; the No. 26, six micrometers from 19 inch to 24 inch, and the No. 28, twelve micrometers from 13 inch to 24 inch. The End Measures fit in grooved slats in base of rack. At the top of these racks hooks are provided for the workman's check. The partitions in these racks, separating the different tools, are made by using rubber plugs, which are screwed to the wooden slats, as shown. The side-members of these racks are iron castings, nicely japanned. The slats are of oak, nicely finished.



No. 20 Set



No. 24 Set

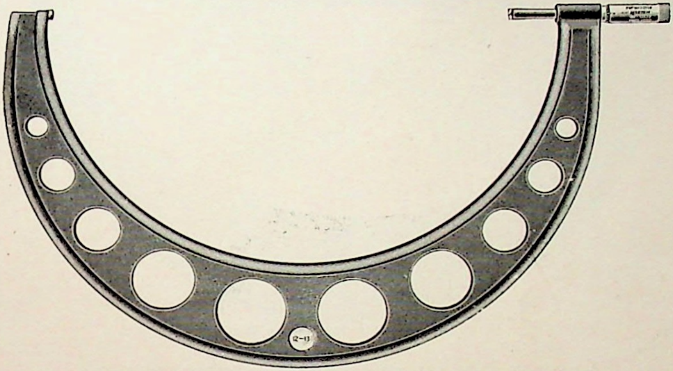

J.T.SLOCOMB CO.
PROV.R.I.U.S.A.
J.T.SLOCOMB CO.
PROV.R.I.U.S.A.

No. 26 Set

No. 28 Set

MICROMETERS FROM 9 TO 24 INCHES

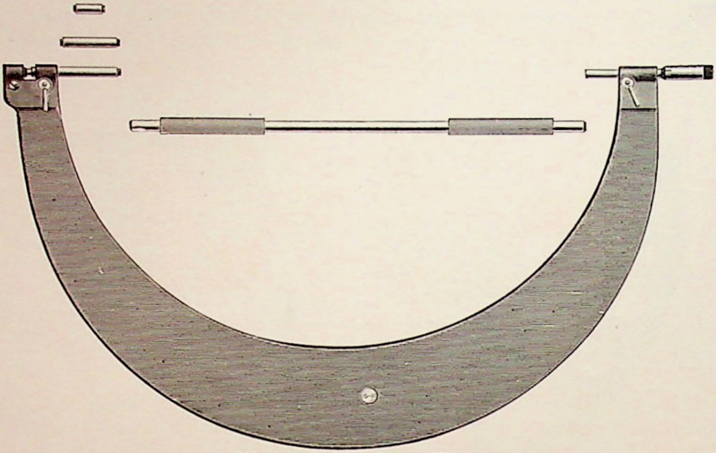
The illustration on page 19 represents a style of micrometer used in measuring from 9 to 24 inches. These calipers are made by steps of even inches, so that fifteen different tools are used to measure a range from 9 to 24 inches. The frames are cast of semi-steel, and finished in black enamel. The micrometer head is forced into the frame from the inside, and the anvil is made of the very best tool steel, hardened and forced into place. These tools are always ready and dependable and are much to be preferred over calipers with a larger range, fitted with attachments or loose pieces. In any shop of more than one man power, more than one gauge has to be provided to avoid delays. These micrometers, in sets, can be used by a number of men at the same time, which is not true of combination tools. Besides, on such tools accuracy must be dependable, and this is impossible in a micrometer with attachments.



Micrometers from 9 to 24 Inches

MICROMETER FOR LARGE WORK

For very large work, say from 24 inches up, there is some economy in using micrometers with more than 1 inch range. By far the best micrometer of this description is shown in illustration on page 20. The three interchangeable anvils in this caliper are standard end measures, a 1 inch, 2 inch and 3 inch. They rest against an adjusting screw and are held by split clamp. A gap is provided so that contact between end measure and adjusting screw can be inspected. In pushing this anvil down dirt is liable to be forced ahead, and caught between the surfaces. In this tool it is a very easy matter to wipe between the surfaces with a piece of paper before making actual contact, and then hold to the light so as to make absolutely sure that the contact is good. With this caliper, one long standard end measure for testing between terminals is all that is required. The short anvil end measures can be measured with a smaller micrometer, so as to be certain of the accuracy of adjustment. In these large calipers a clamp is provided for locking the screw in any position. The frame on this caliper is finished in black enamel. These Micrometers are made to 36 inches.

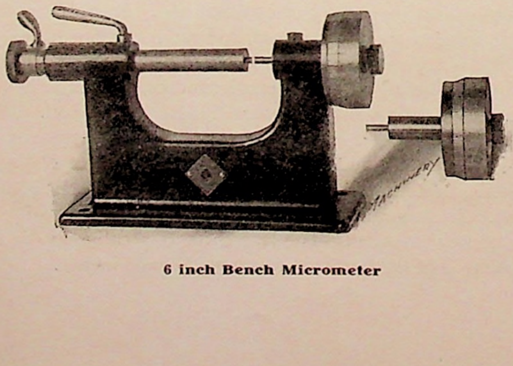


Micrometer for Large Work

NEW SIX-INCH BENCH MICROMETER

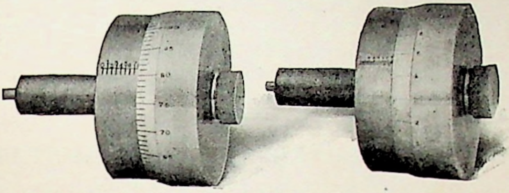
This machine has a range from 0 to 6 inches and is provided with two interchangeable measuring heads. One of these is graduated to read in ten thousandths of an inch direct off the thimble, has a very accurate screw and is suitable for making gauges, or in any work where extra fine measurements are required. The other head has a 10 pitch screw, is graduated to measure in thousandths of an inch, and is intended for work where rapid measuring is required to a degree of accuracy of one quarter of a thousandth.

The thimble in both cases is 4 inches in diameter making the graduations very coarse and in the quick-acting head on account of



6 inch Bench Micrometer

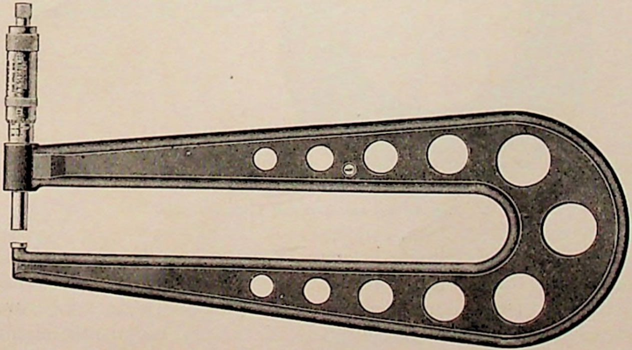
the 10 pitch screw readings are direct; all that is required is to take the first figure from the sleeve and the other from the thimble. As shown in the enlarged cut, the reading is .781¼. The lines and figures are so large that readings can readily be made two or three feet away.



Interchangeable Measuring Heads for 6 Inch Bench Micrometer

The anvil is made with sliding bar held by split clamp in the main bed or frame. This is for approximate adjustments and slides 5 inches. Another adjustment is made through the center of this bar through the knurled head screw shown at the back end. There is a plunger in this bar held back against the adjusting screw by a coiled spring. There is a key fitted in the bar and also another in this plunger so that the anvil does not revolve. The large thimbles are made of aluminum for the sake of lightness.

The head with the 10 pitch screw makes a very useful Caliper for the tool job or where fitting is being done and measurements are taken often as the reading is very plain and measurements can be taken quickly.



Stereotyper's or Rolling Mill Micrometer Gauge

STEREOTYPER'S OR ROLLING MILL MICROMETER GAUGE

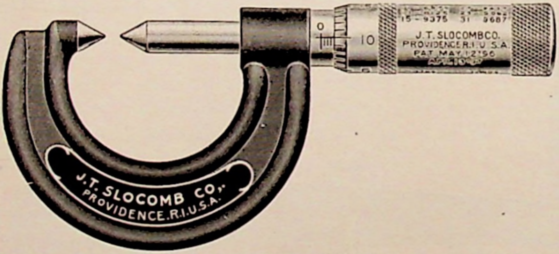
This Micrometer has a range of 1 inch by thousandths and has a depth of gap 9 inches so it will measure to the center of an 18 inch sheet.

They are all provided with our improved friction stop which serves the purpose of a speeder for the screw as well as guarding against springing the frame by applying too much pressure to the thimble.

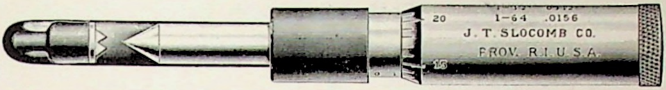
The anvil is made flat for measuring plates, or rounded for use in measuring the curved stereotype plates.

A MILLION DOLLARS' WORTH OF MISTAKES

Will you go on making another million, or avoid it by using Screw Thread Micrometers? These mistakes have been occasioned by the old-fashioned method of cutting threads in the lathe to fit nuts. The trouble is that the first thread on screw is liable to be turned over or thick, and the first thread in nut is apt to be turned, so that you are misled when nut will not enter, and keep reducing thread until nut goes on, then work is spoiled. Right here let us consider how this procedure compares with fitting plain work. If you have a hub with plain bore, and want to turn a shaft to fit, you do not take a cut off shaft, then take it out of lathe and see if it will enter hub; then put it back and take another cut and try again, and keep on trying until it enters. Instead, you caliper the bore in hub, transfer this to your outside micrometer, and make shaft right the first time trying. Why do entirely different in cutting a screw thread? To avoid these mistakes, measure the tap or screw thread standard with a Slocomb No. 29 Micrometer (see cut). Then measure work when finishing thread. You will then know when the size is reached and no mistake about it; also you can cut a few thousandths larger or smaller, if desired, and



No. 29 Screw Thread Micrometer

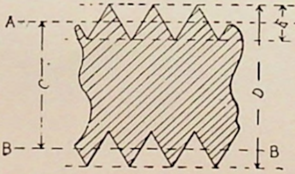


No. 30 Screw Thread

no mistake. We make another Caliper, our No. 30, which will originate a screw thread standard. This tool has a V anvil, and pointed spindle, so that it measures threads at right angles to axis. The No. 29 does not measure at right angles, but measures the work the same as the standard. It is more convenient to use ordinarily, and has a greater range than the No. 30, besides the cost is less.

STANDARD SCREW THREAD MICROMETER NO. 30

These Screw Thread Micrometers provide the best means known of keeping taps, dies, and screw threads generally to standard sizes. The Slocomb Micrometer is especially adapted on account of all adjustments being inside the thimble, and we are therefore able to use a solid anvil, which is much more reliable than when this piece is fitted loose. These tools can be made to measure any form of angle-sided threads from the pitch line without the outside diameter being considered at all. Referring to the small sectional cut, A and B are the pitch lines of the thread and C is the measurement which is shown by these calipers. This is one depth of thread less than outside diameter of screw. It will be seen that the only requirement is that the anvil and point of screw shall bear on the angle sides of thread and not on the extreme top or bottom. For "V" threads, sharp top and bottom, it will be seen that a sharp-pointed screw and anvil fitted to smallest thread required to be measured would measure correctly all other pitches. In practice this small anvil is hard to handle, and it is found better to use a number of different sizes of anvils. The exact number required is largely a matter of opinion. We should recommend one caliper with anvil fitted to a 32 pitch thread to measure pitches from 20 to 32; one fitted to 20 pitch, one fitted to 16 pitch, and one fitted to 10 pitch, to measure all coarser pitches. This would be for "V" threads; for U. S. Standard threads we would recommend twice the number.



Useful Table in Connection with Screw Thread Micrometers

U. S. STANDARD THREADS				"V" THREADS			
Pitch	Subtract from Outside Diameter	Pitch	Subtract from Outside Diameter	Pitch	Subtract from Outside Diameter	Pitch	Subtract from Outside Diameter
20	.0324	7	.0928	24	.0361	11	.0787
18	.0360	6	.1082	20	.0433	10	.0866
16	.0406	5½	.1180	18	.0481	9	.0962
14	.0464	5	.1299	16	.0541	8	.1082
13	.0499	4½	.1443	14	.0619	7	.1237
12	.0541	4	.1624	13	.0666	6	.1443
11	.0590	3½	.1855	12	.0722		
10	.0649	3¼	.1998				
9	.0721	3	.2165				
8	.0812						

The depth of a "V" thread is found by dividing the constant .866 by the pitch number of threads to inch, and for a U. S. Standard, dividing .6495 by number of threads.

It should be stated in ordering, what pitches you wish to measure, and whether "V" or U. S. Standard threads.

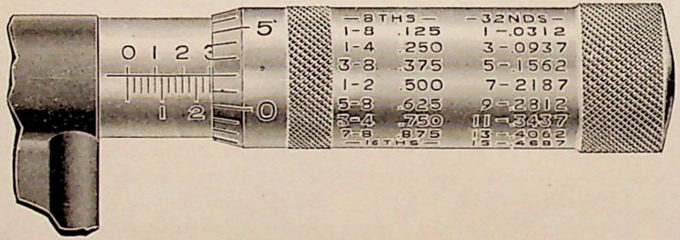
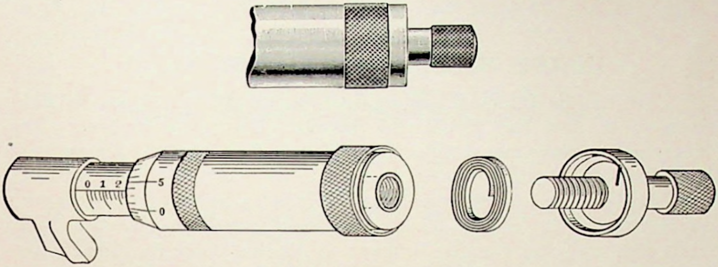


Table of Decimal Equivalents Rolled on Micrometer Thimble

This table consists of Decimal Equivalents of 8ths, 16ths and 32ds rolled almost completely around Thimble.

NEW FRICTION STOP

This device is used to gauge the pressure upon work in measuring. The tension is adjusted correctly, so when proper pressure applied to Thimble, by turning the small knurl projection, is exceeded, this device will slip. It is also a speeder, as, on account of its reduced diameter, the Thimble can be turned faster than where the fingers are applied directly to the Thimble.

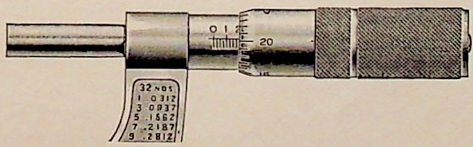


New Friction Stop

This device consists chiefly of a coiled flat spring of german silver. The inner end of this spring is attached to washer, which is clamped to end of thimble by shoulder on central screw. The outer end slides around inside of large bore in outer revolving part; so arranged that in turning to the right the device slides over the spring, but in turning to the left the friction uncoils the spring, causing it to drive positively in this direction. This device has no parts that are liable to get out of order, and allows of a large and substantial screw for attaching; also allows of reducing the knurled part to small diameter, so as to provide a speeder as well.

The german silver spring does not require lubrication, and as there is so much of it, it will not wear so as to lose its tension.

Another advantage is in the absence of click, which makes such a device rough in its action, and does not stop so positively as this friction device.



New Friction Thimble

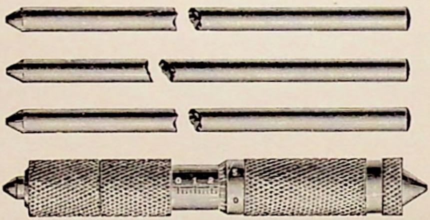
The construction is practically the same as the friction stop on end of Thimble.

With a friction or ratchet stop micrometer it is necessary to hold the micrometer in one hand and work the end piece with the other.

With friction thimble micrometer the hand that holds the tool also works the friction thimble.

INSIDE MICROMETER GAUGE No. 11

This tool is intended to measure inside diameters above 2½ inches. It does not measure a definite distance in inches. The micrometer screw has a range of ¼ inch, which enables allowances or differences of this amount, or less, to be accurately measured in thousandths; the diameter or length only being limited by the length of rod, which for long lengths can be readily cut from standard 5-32 steel rod, rods to measure diameters to 9 inches being furnished with the tool.



Inside Micrometer Gauge No. 11

REFERENCE DISC.—STANDARD END MEASURE

Reference Disc

For keeping standard gauges to accurate size, reference discs and standard end measures are used, as per illustrations. For small sizes, such as for adjusting a one or two inch micrometer, the reference disc is recommended, for large sizes the end measure. These gauges are made to a high degree of accuracy. They are made of the best tool steel, hardened and afterwards heat treated, in a way to season them. A peculiar thing about hardened steel is that it will shrink to some extent, and unless treated properly will continue to shrink for a year or more. Gauges to be accurate and lasting, must be treated to avoid this shrinkage. These standards should be used for reference only, so their accuracy may be lasting. Where much adjusting is done, as in a large shop where thousands of gauges are used, there should be two or more sets of standards, one for everyday use and one for reference only. In handling these gauges great care must be exercised to guard against changes by temperature. With a twelve-inch end measure a slight grip of the bare hand will often increase the length from two to five ten-thousandths.

End Measure

End Measures are provided with rubber cover. This cover is an insulator, so that the gauges can be handled by the cover without changing temperature greatly. Considerable care should be taken of these standards to guard against rust or abrasion on their measuring surfaces. It should be understood that these gauges are liable to wear from excessive or careless use, and that they should be used by competent men only.

TO READ A MICROMETER

A Micrometer is very easily read, but of course, like many other things, rapid work is obtained only after some practice.

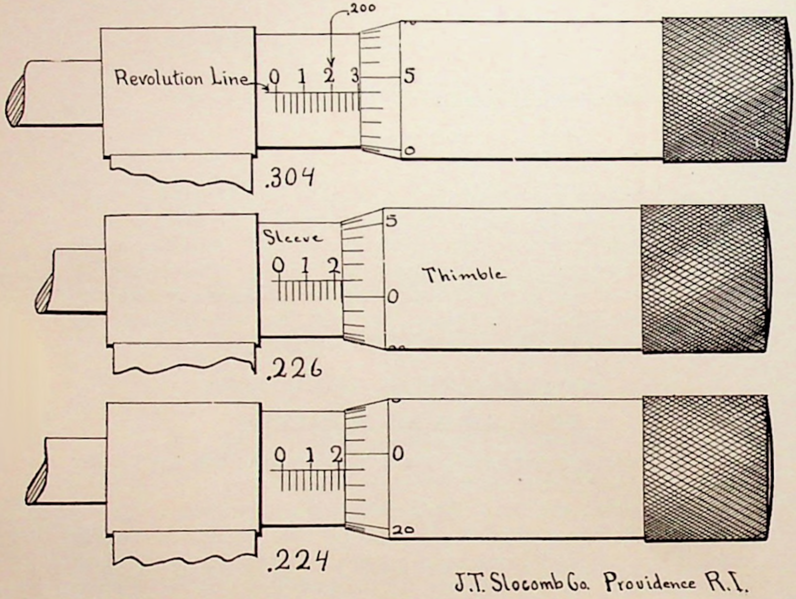
Many machinists read the Micrometer almost at a glance.

The Micrometer divides the inch in 1000 parts. As usually made it has a 40 pitch screw which advances through its nut .025 inch per revolution. It is evident that, if measurements are to be made of .025 inch or less, all the graduating can be on the end of revolving thimble only, and all that would be necessary besides this would be an indicating line on stationary part.

To measure a greater range it is necessary to have some means of counting and adding together the additional revolutions of screw. This is done in an ingenious and very simple manner by the graduating and numbering used, and is plainly illustrated by cut, which is made about twice actual size.

The cross lines on sleeve are spaced .025 inch apart to equal the pitch of screw. A revolution line is cut lengthwise of the sleeve which in connection with the zero line on thimble counts whole revolutions of screw. When end of thimble matches any of the cross lines and the zero line matches with the revolution line, the number of spaces exposed denote the number of revolutions made. Every fourth cross line is numbered from 0 to 10.

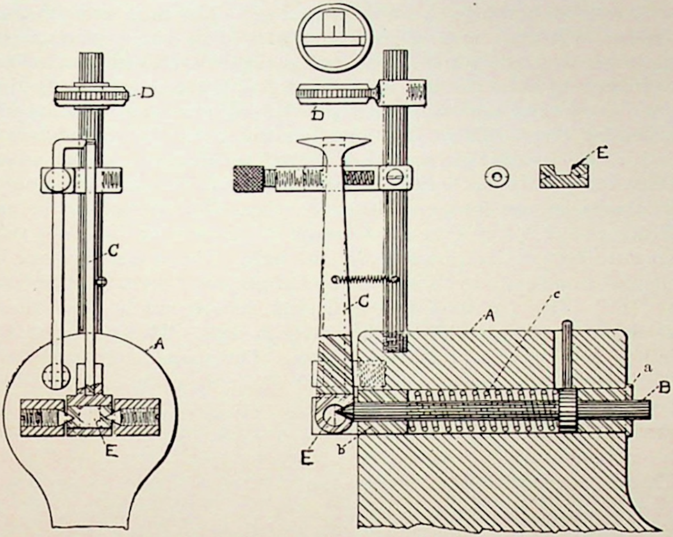
In the first illustration the reading is .304 showing 300 on the sleeve and .004 on the thimble. In the second illustration the reading



is .226 showing .225 on the sleeve and .001 on the thimble. In the third illustration the reading is .224 showing .200 on the sleeve and .024 on the thimble.

The figures should be taken off the sleeve as hundreds, that is, 100, 200, 300, etc. The thimble is shown purposely close to the lines in the cut as these are the points where a mistake would be most likely.

In the .226 reading while the end of the thimble may appear to match the cross line, it is evident that it does not for the reason that the zero lines on thimble and sleeve do not coincide but are one space advanced which, of course, we add to the .225 making the reading .226. The same is true in the .224 reading, but the zero line has gone by one space making the reading .224.



Anvil—Slocomb Measuring Machine

A very good way to begin in teaching a man who has never used a Micrometer is to let him take a one inch size, run it down to zero or against the anvil, then have him turn the screw back, counting the graduations on thimble for four turns counting these graduations to 100. He then readily sees the use of the cross graduating and how it helps him to count.

ANVIL ARRANGEMENT USED ON MEASURING MACHINE

The preceding illustration represents an arrangement we use on our measuring machines for knowing absolutely the amount of pressure applied to work when measuring. It is well known that when measuring to an accuracy of .0001 inch or less with ordinary micrometer, it is difficult to know just how much pressure is applied on the work. In the preceding illustration "A" represents a section through part of the tail stock of measuring machine, "B" is a plunger anvil. This is a nice sliding fit through bushing "a" and "b." This plunger anvil is kept against bushing "a" by spring "c." The back end of this plunger is formed to a 60° angle point. This angle point rests against indicating lever "C." There is also a small spring attached to indicating lever to keep it in contact with the plunger. At the top of indicating lever there are two arcs, one stationary and one on indicating lever. There is a zero line cut across these two arcs, and a magnifying glass provided at "D" so that the variations of these lines can be easily seen. There is also provided an adjustment on stationary arc for convenience in using. The proportion of indicating lever is such that a movement of plunger "B" of .0001 will separate lines on indicating lever 1/64 inch. The indicating lever is enabled to magnify to this extent by the peculiar fulcrum pin, shown at "E." This pin is of hardened steel, halved out in the center, as shown, and is provided with centers in ends. This pin is forced in hole in lower part of indicating lever. The pointed end of plunger "B" rests against flat of pin "E" just above the center. Indicating lever is pivoted by pointed screws entering centers in pin "E" as shown. By this arrangement we are enabled to use an indicating lever with the long arm 4 inches, and short arm about .027 inch. Then by the magnifying glass this is still further increased four times.

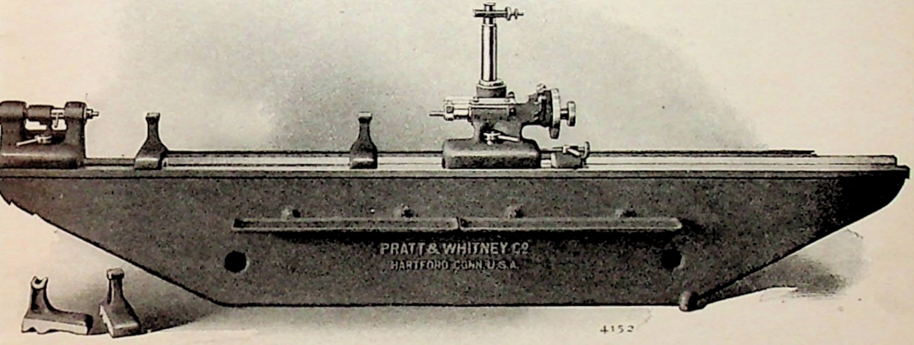
REGARDING RELIABLE MEASUREMENTS

A thoroughly reliable Standard Measuring Machine should not depend for its setting on steel plugs or end measures that are liable to wear. J. T. Slocomb Co. use a 36 inch Pratt & Whitney Measuring Machine. In this machine the locating of head for even inches is done by setting to lines on a graduated bar by the help of a powerful microscope. The lines on this bar are about 1/10000 inch wide, and are too fine to be seen by the naked eye. By this arrangement there can be no wear on the standard, consequently the greatest reliability. The following is taken from a catalog issued by the Pratt & Whitney Co., Hartford, Conn., by their consent:

"The illustration shows the latest model of the Pratt & Whitney Standard Measuring Machine. In redesigning this machine, every point brought out by experience with previous models has been carefully considered, and if practical to do so has been incorporated in this model, making it the most complete machine of its kind on the market.

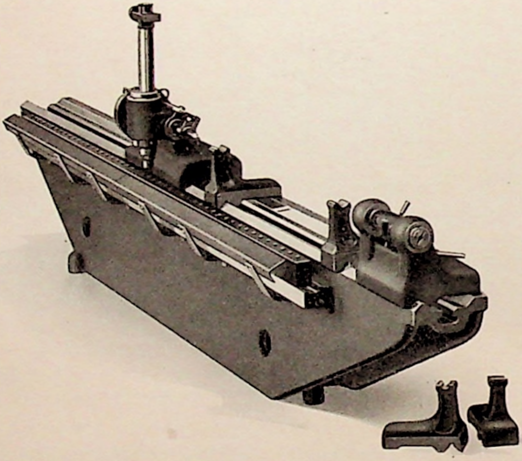
"An important improvement in the machine is the raising of the standard bar at the rear of the machine to a position nearly level with the surface of the bed. This reduces to the lowest degree any error that may arise from reading with the microscope. The bed is nearly twice the weight of previous models and is of massive construction, resting on three neutral points, and cannot easily be affected by temperature or flexure. The sliding head which includes the screw and index is carefully fitted, insuring parallelism of the measuring faces at any position along the bed up to the capacity of the machine.

"The screw is standard 25 threads per inch, or one millimeter pitch for Metric System, and has adjustment for wear in both nut and shoulders. Particular attention is called to the calipering attachment, which is simple in the extreme, and solves completely the problem of end measurements within the limits of accuracy attainable in line reading by means of the microscope and micrometer eyepiece. The standard bar to which the end measurements are referred is not touched during the operation, and each measurement is derived from the same zero, so that error from end wear does not enter into the problem.



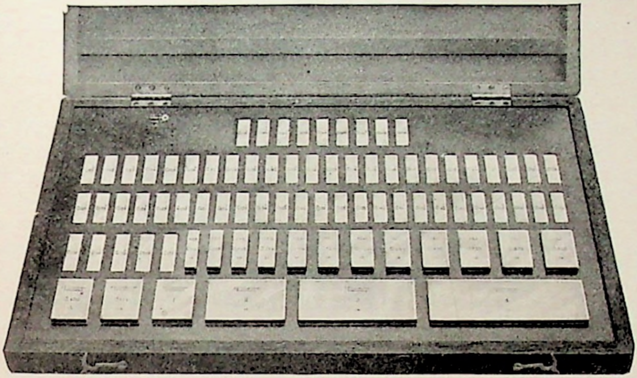
The Pratt & Whitney Measuring Machine

"A strong feature in the operation of this machine is the comparing of all measurements with a carefully divided and investigated standard bar, the divisions of which are marked upon hardened and polished steel plugs set into a soft steel bar. This bar is never handled, is covered when not in use, and can in no way be injured when calipering except by accident. Delicacy of contact between the measuring faces is obtained by the use of auxiliary jaws holding a small cylindrical drop plug by the pressure of a light helical spring, which also operates the sliding spindle, to which one of the auxiliary jaws is attached. The instant the calipering surfaces are brought into perfect contact, either directly or through the work, the tension on the spring is so adjusted that the plug which is held in a horizontal position by friction will swing toward a vertical position, any excess pressure causing the plug to drop out. An adjusting device for the index line provides for any slight variation of the position of the calipering faces at zero.



"The British Imperial Yard, which is carefully preserved at the Royal Observatory at Greenwich, consists of a bronze bar 38 inches long, with two gold plugs inserted at a distance of 36 inches apart. Upon the polished surfaces of each is a very fine line, the distance between which, at a temperature of 62° Fahrenheit, represents the standard yard from which all English measurements are derived.

"The Standard Meter established by law consists of a bar of platinum and iridium, 90 parts of the former to 10 parts of the latter. This is an end measure and derives its length from the report of a commission appointed by the French Government, and which recommended a measure derived from a quadrant of the earth's meridian divided into ten million equal parts, the meter being a subdivision and is equal to 39.370788 inches English measure.



Johansson Gauges

"This bar is standard only at 0° Centigrade, and is kept in the International Bureau at Breteuil, between Paris and Versailles, where we have recently had plugs verified.

"Upon these two standards Pratt & Whitney Measuring Machines are based. The English graduated machines are standard only at 62° Fahr., and the Metric Machines at 0° Centigrade.

"It is understood, however, that it is not necessary to use the machines at the initial temperature, as once standardized any variation of temperature will affect both the work and the machine alike, and give readings that will be correct for light materials, not only at the initial temperature, but at any temperature at which the readings may be taken.

"Machines for English measurements have 400 graduations on the index circle, reading to 1/10000 inch, and for metric measurements have 500 graduations, reading 1/500 millimeter (1/12500 inch nearly). These divisions can easily be subdivided into quarters or even less by estimation."

JOHANSSON GAUGES. USED BY J. T. SLOCOMB CO.

The Johansson Gauges are, without doubt, the most accurate standards known. In order to keep Micrometer Calipers to the very closest limits of accuracy, the most accurate and reliable gages are a necessity. In making gages to an accuracy of one ten-thousandths, it is evident that the master gages must be very much closer than this. It is claimed that these Johansson Gauges can be made to an accuracy of one millionth inch. However this may be, it is a fact that these gages are more accurate than heretofore produced. This set of gages consists of 81 blocks so proportioned that any measurement can be obtained by ten thousandths of an inch by piling them together. The surfaces are so accurate that when they are perfectly clean, these blocks will wring together excluding the air so as to hold together with remarkable firmness. With this set of gauges we are able to test our Micrometers at any point of their graduations; also we are able to correct our master screw to the highest degree of accuracy. By locking together three of these blocks so that the outside ones overlap, forming an external gage held together by air pressure only, it is possible to insert another standard of exactly the same dimension, pushing it through while removing the first center plug, making the second one take its place without breaking the joint. This seems to disprove the common idea that a plug must be smaller than a hole in order to enter. It is possible that the air pressure allows these blocks to separate to some extent, but it must be an almost inconceivable amount.

MAKING PROPER ALLOWANCES FOR VARIOUS CLASSES OF FITS

The question often occurs how much allowance to make for a certain kind of a fit. If the fit must be a tight one, forced or shrunk together, the shaft must be larger than the bore. If the hub is of soft and tough metal, such as soft steel or bronze, and is thin, it is evident that some allowance must be made for the stretching of metal in hub. If the surfaces are rough, rough turning and rough boring, some allowance must be made for the flattening down of these rough surfaces. Then again, the bore and shaft are often out of round and not axially true. A shaft that is out of round is often larger than it measures, also a bore that is not axially straight appears smaller than it is, in a running fit. Cored holes bored by various kinds of reamers only, are liable to be crooked on account of tools springing, and so following, to some extent, direction of core. For this reason, as a rule, a long bearing, in a running fit, requires more allowance than a short one. Where surfaces are hard and perfectly true and smooth, as in Standard Plug and Ring Gauges, very small allowances suffice.

The following table of allowances will be found useful for good average machine work:

FORCE FITS (for Shafts)	DRIVING FITS (for Shafts)
Up to ½ in. + .0005 to .001	+ .0004 to .0006
½ in. to 1 in. + .001 to .003	+ .0004 to .001
1 in. to 2 in. + .002 to .004	+ .00075 to .002
2 in. to 3 in. + .003 to .006	+ .0015 to .003
3 in. to 4 in. + .005 to .008	+ .002 to .004
4 in. to 5 in. + .006 to .010	+ .002 to .0045
5 in. to 6 in. + .008 to .012	+ .003 to .005
PUSH FITS	RUNNING FITS
Up to ½ in. — .00025 to .00075	— .00075 to .0015
½ in. to 1 in. — .0005 to .001	— .001 to .002
1 in. to 2 in. — .0005 to .0015	— .0015 to .0025
2 in. to 3 in. — .0005 to .0015	— .0015 to .003
3 in. to 4 in. — .00075 to .002	— .002 to .0035
4 in. to 5 in. — .00075 to .002	— .0025 to .004
5 in. to 6 in. — .00075 to .002	— .0025 to .0045

THE MODERN SHOP

We view the modern machine shop with a great deal of satisfaction, for it bears out the contention we have always made that in time the haphazard way of working and measuring would be discarded for something accurate and comprehensive.

The writer's experience in an old shop in Maine over thirty years ago strongly impressed upon his mind the necessity of an improvement in the means of measuring in machine shops. The loss occasioned by some of their ways of measuring would hardly be believed in an up-to-date shop to-day.

One instance of this was in the finishing of line shafting. These bars were turned from black stock, usually to the largest diameter that would finish out. While a 2 inch shaft was normally 1-15/16, different orders were liable to vary as much as .025. Such work was scattered all over the country in various sawmills and other factories, and when it became necessary to add more pulleys or make changes, the mill had no means of measuring this shaft, so sent an approximate measurement for the shafting. I have seen a factory hung up for a week after an order had been received because of the fact that the parts did not fit, all of which could have been avoided by the use of Micrometer Calipers.

Even in these days we find the question of proper measuring is not appreciated to the extent that it should be. To make the Micrometer the greatest success in a shop, it is necessary that the workman be educated to its use. This is not a difficult matter, and there is no occasion for mistakes in the reading. Such things are due to the fact that the workman has not had a proper education and practice with these tools. Micrometer Calipers will take the place of thousands of solid gauges, besides they will do a great deal better work and in a much more comprehensive manner.

Another fact that is not generally known is that Micrometer Calipers are far more accurate than the average snap gauge found in machine shops.

We feel very sure that the suggestion of comparing the use of the Micrometer Caliper with the steel rule, as brought out at the beginning of this book, would lead to the best results in most shops if properly appreciated.

COMBINATION CENTER DRILLS

Although not measuring tools these drills are one of our strong specialties, and we think best to tell our story here in regard to them. We have been making these tools for the past twenty-three years. We made them commercially practical by building special machines for their manufacture and placing them on the market of a quality and at a price that made them a success.

We were entirely alone in their manufacture for the first six or seven years, but after having proved them successful we have had some competition. We feel that this is something of our making, and this is one reason that we are greatly interested in this tool. Our intention is to make the very best tools possible, and we have gone to great expense with special machines and means of testing to insure the very best quality.

Among the devices we use is a form of dynamometer for testing the strength of finished drills. This appliance is used on a sensitive drill press. In this device there is a coiled spring used inside the driving pulley arranged in such a way that the spindle is driven through this spring. Between the pulley and the final hub that drives the spindle there is a coarse screw so arranged that when the spring winds or tightens by the pressure of driving, this hub screws off the thread to an amount depending upon the compression of the spring; an indicator arm resting against this movable hub indicates the amount of its end movement on a graduated arc which is magnified to a considerable extent. There is also a sliding friction arm on this graduated arc so arranged that it will stay and register the highest movement of the indicator arm.

In use, a drill is fed into the work in the regular way, using a heavy feed sufficient to break the drill, when the breaking strain is registered.

The device is graduated to read pounds on a 4 inch radius.

After making many tests we have made a record of what may be expected of first-class drills, and so by trying with this device a number out of each lot, we are able to note any change in the quality.

We also use an electric pyrometer in our lead bath for heating, an improved tempering device, and a number of other improved testing and comparing devices.

Our drills are now made of semi-high speed steel, which is a tungsten alloy, giving great strength. This is a high price steel, but we charge no more for the drills than those made of carbon steel.

We can make these center drills in a great many styles, shapes, and sizes, for drilling and countersinking the different sizes of machine and wood screws, or for other places where counterbores are used, and can quote prices on special work.

DIAMETERS OF CENTERS, SIZES OF CENTER DRILLS AND SPEEDS RECOMMENDED

These sizes are for centers to be left in finished work. Before squaring up, some allowance will have to be made. The speed of drills given is for soft steel or iron. Where there is much turning to be done on a piece of work it is advisable to use larger centers, even if they have to be squared out on finishing the work. For lathe-arbors or other work where considerable wear comes on centers, it is advisable to make them a great deal larger, in fact, as large as the work will allow. Where an arbor press is used the centers can be larger than where arbors are driven with a lead hammer, for the

Diam. Work	Diam. Countersink	Use Size	Drill Speed
3/16 inch	3/32 inch	"H"	2000
1/4 inch	7/64 inch	"E"	1700
5/16 to 1/2 inch	1/8 inch	"E"	1700
9/16 to 3/4 inch	9/64 inch	"D"	1500
13/16 to 1 inch	3/16 inch	"D"	1500
1 1/16 to 1 1/4 inches	7/32 inch	"C"	1000
1 5/16 to 1 1/2 inches	1/4 inch	"C"	1000
1 9/16 to 1 3/4 inches	9/32 inch	"C" or "B"	
1 13/16 to 2 inches	5/16 inch	"B"	800
2 1/16 to 2 1/2 inches	3/8 inch	"F"	500
2 1/2 to 3 inches	7/16 inch	"G"	500

reason that where a hammer is used the flat surface of arbor end should be as large as possible. In lathe arbors it is advisable to round edge of countersink, so that in putting work upon centers the liability of injury to countersink is lessened. For diameters of drill points on our stock size center drills, please see page 58, our catalog. In using Combination Center Drills the best result is obtained by running drill at speed suitable for drill point, and feeding the same as you would for a Twist Drill of this small diameter. When the countersink begins to cut it is best to feed rather lighter, giving the chips a chance to work out.

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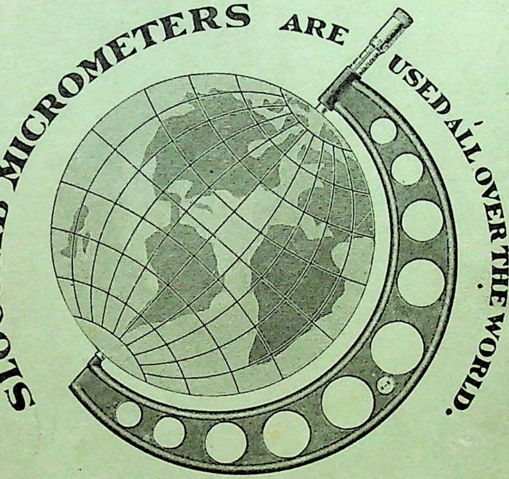
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